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Methodology to Assess Field of View of Maxillofacial Protective Devices

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14. ABSTRACT
The frequency of maxillofacial battlefield injuries has steadily increased since World War II. While anecdotal reports from the Army aviation community credit maxillofacial shields (MFSs) with preventing aircrew injury during aviation mishaps, however no MFS exists to prevent combat-related maxillofacial injuries to ground Warfighters. MFSs that attach to combat helmets are being developed to provide facial protection to ground and mounted troops. An important consideration when developing maxillofacial protective devices is to achieve a balance between the protective coverage and the field of view (FOV) blockage induced by wearing MFSs. This study compared subjective and objective methodologies to measure the FOV of proposed MFSs. This evaluation showed that the use of objective methodology yield similar results compared to the subjective FOV methodology. The use of the objective FOV methodology will expedite the test and evaluation of future MFSs and give more accurate results by eliminating the variability induced by differences in subject responses.

15. SUBJECT TERMS
field of view, FOV, facial protection, maxillofacial shield, Advanced Combat Helmet, ACH, Combat Vehicle Crew Helmet, CVCH

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Background

Historically, the overall frequency of face and neck battlefield injuries has increased since World War II and the Korean War. During both of these conflicts, approximately 21percent of all injured U.S. service members suffered wounds to the head and neck (Beebe & DeBakey, 1952; Reister, 1973). In contrast, 26 percent of all battle wounds in Operation Iraqi Freedom (OIF) and Operation Enduring Freedom (OEF) involved craniomaxillofacial injuries (Lew, Walker, Wenke, Blackbourne, & Hale, G 2010). Penetrating soft-tissue injuries and bone fractures accounted for 58 percent and 27 percent of these craniomaxillofacial injuries, respectively. Improvement to body armor has increased Warfighters' survivability of many previously fatal injuries. Anecdotal reports from the Army aviation community credit maxillofacial shields (MFSs; figure 1) with preventing aircrew injury during several aviation mishaps. An aircrew MFS protects the aircrew's lower face from ballistic fragmentation and blunt impact as well as from rotor wash, flying debris, and windblast during helicopter operations. While anecdotal reports like these illustrate the protective nature of MFSs, no maxillofacial protection devices exist to prevent combat-related maxillofacial injuries to ground Warfighters.

Figure 1. HGU-56/P aircrew helmet with maxillofacial shield.

Maxillofacial protective devices that attach to the Advanced Combat Helmet (ACH) and the Combat Vehicle Crew Helmet (CVCH) are being developed to provide facial protection to ground and mounted troops, respectively. As the "honest broker" for the Warfighter, the U.S. Army Aeromedical Research Laboratory (USAARL) works with program managers to evaluate protective devices. With the increasing need to provide Warfighters with ballistic, blast, and blunt impact protection to the maxillofacial region, it is essential to understand potential operational problems associated with wearing maxillofacial protective devices. An important consideration when developing maxillofacial protective devices is to achieve a balance between the protective coverage and the field of view (FOV) blockage induced by wearing maxillofacial protective devices. While subjective assessment using a perimeter is commonly used to measure FOV, this methodology is very time consuming, requires the recruitment of test participants, and calls for potential modification to the perimeter to accommodate the bulky maxillofacial

protective devices. In addition, subjective FOV results are more variable due to differences in subject's response time and device fitting. The present report compares subjective FOV measurements to a newly developed objective method that uses a head form and a laser pointer to determine the extent of FOV blockage induced by wearing maxillofacial protection devices attached to the ACH and CVCH.

Methods

Subjective assessment

Eight volunteer test participants were included in the subjective FOV evaluation. The Revision Baltskin Mandible Guard (Revision 2012), referred here as MFS (maxillofacial shield), was used for the evaluation. The FOV for each participant was measured under four test conditions using the: 1) ACH alone (unrestricted FOV); 2) ACH/MFS; 3) CVCH alone; and 4) CVCH/MFS (figure 2). The FOV was measured using the Goldmann (Haag-Streit) perimeter while the participant, who sat in a dark room, wore the helmet with and without the MFS (figure 3). The perimeter chin rest was modified to fit under the MFS allowing for vertical and front-back adjustment to properly align the participant inside the perimeter (figure 4, right image). The target stimulus was a high contrast, 1-millimenter (mm) diameter circle of white light that was projected on a hemisphere at a distance of 33 centimeters (cm) from the participant's eye. The stimulus luminance was 50 foot-lamberts against a background luminance of 0.25 foot-lamberts. The investigator moved the illuminated target located at one of the 12 azimuths (30-degree intervals: 0, 30, 60, 90…330 degree) in relation to the participant's right eye (figure 5). The illuminated target was moved at a steady rate (40 to 50 degrees) starting from the periphery towards the center. The target was always presented from a non-seeing to a seeing area and the participant signaled as soon as the target was seen. The target was brought in three times and the median reading was recorded for each azimuth. The FOV was tested randomly in all 12 pre-determined azimuths.

ACH (unrestricted) ACH/MFS CVCH (unrestricted) CVCH/MFS

Figure 2. Subjective FOV test conditions.

Since the MFSs are symmetrical around the eyes, the resulting fields of view (FOVs) are also expected to be symmetrical. Therefore, FOV measurements were conducted monocularly for the right eye only at 12 azimuths. While the upper and lateral FOVs are not expected to be affected

by wearing protective MFSs, the FOVs in these areas were measured to verify proper participant alignment throughout the testing. In addition, to ensure the participant's position did not change during the testing, the participant wore rimless clear protective eyewear that had a 5-mm black dot located directly in front of the pupil of the right eye. The participant kept the black dot on the eyewear aligned with the fixation target located in the center of the perimeter hemisphere.

Figure 3. The Goldmann (Haag-Streit) kinetic perimeter. Perimeter demonstrated in a fully-lighted lab: test participant side of the perimeter (left image) and investigator side of the perimeter (right image).

Figure 4. Modified perimeter chin rest. The original chin rest (left image) was modified (right image) to fit under the MFS and to allow participant alignment.

Before initiating the testing, the investigator explained the evaluation to the participant, emphasizing the need to signal as soon as the illuminated target was seen and the importance of maintaining fixation as instructed. The participant was also instructed to blink normally any time during the testing. The untested eye (i.e., left eye) was occluded during the testing. The investigator ensured the proper fitting of the helmet and the helmet/MFS combination before the participant was assisted to position the chin onto the perimeter chin rest (figure 3, left image). The investigator adjusted the height of the perimeter table and/or the chin rest as appropriate to achieve proper participant alignment and comfort while in the testing position inside the perimeter hemisphere. After the completion of the FOV evaluation, the participant was allowed to rest for at least 5 minutes between test conditions to prevent fatigue. The entire series was repeated with all four test conditions.

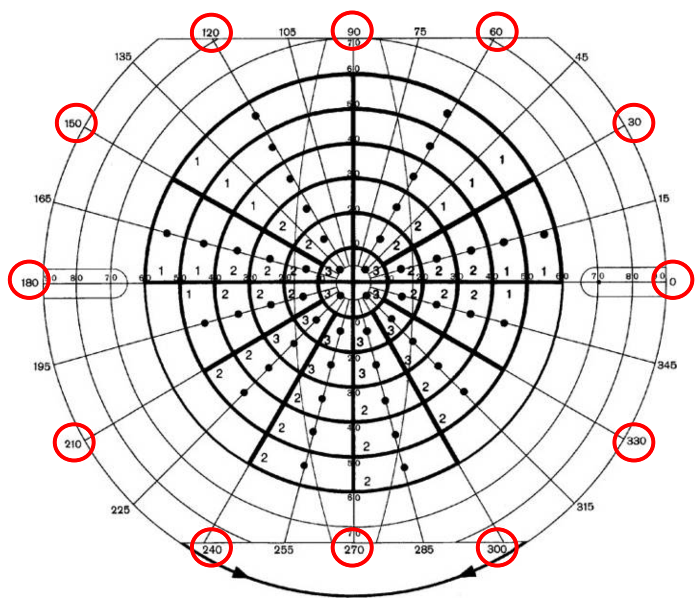

Figure 5. Polar meridian coordinates for subjective FOV measurement. FOV was measures in 12 azimuths at 30-degree increments (0, 30, 60…, 300, and 330) from the perspective of the right eye.

Objective assessment

The objective FOV measurements were completed using a head form on a rotating table and an inclinometer with laser pointer (figure 6). A mount was made to attach the laser and the digital inclinometer, which could slide up and down approximately 1 meter. The inclinometer had degrees of tilt values in 0.1 units. To determine and assure that the pupil of the rigid head form was positioned at the center of rotation of the turn table, a long optical mounting rod was first screwed into the center of the rotating table. The laser on the vertical mount was activated, and the rotating table was moved laterally until the laser intercepted the center of the optical rod.

The optical rod was removed and the head form was then placed on the rotating table and moved laterally until the laser intercepted the pupil marked on the head form. The head form was then rotated about the yaw axis 90 degrees. The head form was then moved perpendicular to the laser beam until the laser beam aligned approximately 3-mm behind the apex of the cornea.

The different helmet/MFS combinations were mounted on the rigid head form, and the laser was moved up and down, changing pitch, to align with the marked pupil on the head form. The laser height and pitch were adjusted until the laser intercepted the pupil of the head form and either the helmet structure for the upper FOV or the MFS for the lower FOV. Only the left eye measurements were taken from 50 degrees azimuth nasally to 90 degrees azimuth temporally. Figure 7 shows the lower FOV measurements alignment point, and figure 8 shows obtaining the upper FOV measurements.

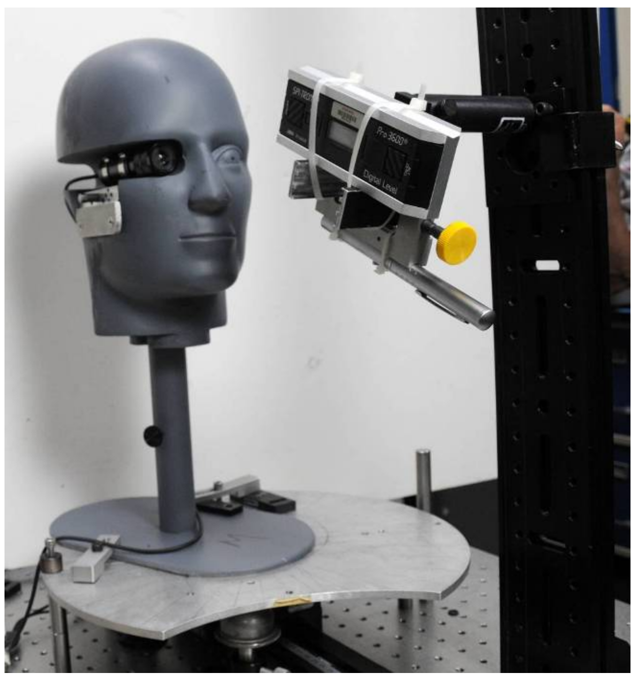

Figure 6. Objective FOV assessment set up. The apparatus set up to measure angular objective FOV using a head form, rotating table, digital inclinometer, laser pointer, and a vertical optical mount.

Figure 7. Objective assessment of the lower FOV. Height of laser adjusted to intercept edge of the MFS and pupil of the eye to determine lower FOV angle.

Figure 8. Objective assessment of the upper FOV. Height of laser adjusted to intercept edge of the helmet and pupil of the eye to determine upper FOV angle.

Data analysis

The FOVs were measured with the Goldmann perimeter in polar meridian coordinate in 30-degree increments for all four test conditions. These FOV values, in polar meridian coordinates, were averaged for each meridian. Since the MFSs mainly affect the lower FOV, the average vertical FOV was calculated for each test condition. To calculate the average vertical FOV for each test condition, the average polar meridian coordinates were converted to linear degree measurements in *x*- and *y*- coordinates. The averaged *y*-values provided the linear degree of vertical FOV for each test condition. This conversion allowed the comparison of the subjective and objective FOV values. The FOV percent loss was determined by the equation: (1 – (average vertical MFS FOV/average vertical unhindered FOV))*100. The *t*-test was used to determine whether there was a significant difference between the mean FOV measured by the two methods. The FOV values for the right eye were used to create a symmetrical mirror image representing the left eye FOV. Binocular FOV graphs were plotted by combining the FOV data from the right eye and its mirror image for the left eye. These graphs portray the FOV from the observer's perspective. The lines within the graph represent the mean FOV for each test condition and can be easily compared when overlaid on a single graph in lines of different colors or styles.

Results

Tables 1 through 4 list the FOV results of the subjective measurements in polar degrees as well as the mean FOV and standard deviation at each tested azimuth while the participant (indicated as TP in the tables) wore the ACH or CVCH with or without the MFS. Tables 5 through 8 show values converted to linear degree measurements in *x*- and *y*- coordinates. The averaged *y*-values provided the linear degree of vertical FOV for each test condition. Tables 9 and 10 list the FOV results of the objective measurement at each tested azimuth while wearing the ACH or CVCH with MFSs. As expected, wearing an MFS had no effect upon the superior and superior-lateral FOV. However, the MFSs reduced the FOV in 5 azimuths (i.e., 210, 240, 270, 300, and 330) in the inferior hemisphere, with both helmets. Compared to baseline values while wearing the ACH alone, wearing the MFS decreased the vertical FOV by 15.9, and 12.4 percent when measured with the subjective and objective methods, respectively (table 11). The MFS mean vertical FOV measured with the subjective and objective methods decreased by 23.8 and 21.0 percent, respectively when compare to the CVCH alone. A *t*-test showed that the difference between the means of the objective and subjective measurements were not statistically significant while wearing the ACH ($p = 0.44$) or CVCH ($p = 0.55$). Figures 9 and 10 show the individual FOV plots comparing the measurements obtained with the subjective and objective methods, respectively, for the each helmet/MFS combination. To determine the accuracy and stability of the laser method using repeated measures, the upper and lower FOVs were alternately measured at the zero azimuths for 10 measurements each using the CVCH/MFS combination (table 12).

Table 1.
Subjective FOV (polar degree) for ACH (unrestricted; helmet only).

Azimuth	TP #1	TP #2	TP #3	TP #4	TP #5	TP #6	TP #7	TP #8	Mean	SD
0	90	88	90	90	92	92	90	85	89.6	2.3
30	65	65	50	70	70	68	58	65	63.9	6.8
60	55	55	45	45	48	48	40	45	47.6	5.2
90	45	45	40	42	42	42	37	40	41.6	2.7
120	50	50	45	45	48	48	40	45	46.4	3.3
150	55	55	40	52	53	52	55	50	51.5	5.0
180	40	40	40	46	46	46	48	44	43.8	3.3
210	45	40	38	42	42	43	52	45	43.4	4.2
240	60	52	50	56	50	58	53	62	55.1	4.6
270	63	70	75	60	59	65	69	63	65.5	5.5
300	78	80	85	88	88	88	75	83	83.1	5.0
330	90	95	90	92	92	92	88	92	91.4	2.1

Table 2.
Subjective FOV (polar degree) for ACH/MFS.

Azimuth	TP #1	TP #2	TP #3	TP #4	TP #5	TP #6	TP #7	TP #8	Mean	SD
0	88	94	90	89	94	94	89	85	90.4	3.3
30	65	65	50	68	69	69	58	65	63.6	6.6
60	55	55	43	45	47	48	42	45	47.5	5.0
90	45	45	40	42	42	40	39	39	41.5	2. 5
120	50	50	43	45	48	48	40	45	46.1	3.5
150	52	55	40	52	53	52	56	48	51.0	5.0
180	45	41	40	46	45	45	45	43	43.8	2.2
210	45	40	35	38	38	38	45	43	40.3	3.7
240	50	38	62	35	35	35	45	62	45.3	11.7
270	36	43	33	30	38	30	31	37	34.8	4.6
300	55	65	68	75	77	76	72	74	70.3	7.4
330	79	95	90	90	90	90	86	88	88.5	4.6

Table 3.
Subjective FOV (polar degree) for CVCH (unrestricted; helmet only).

Azimuth	TP #1	TP #2	TP #3	TP #4	TP #5	TP #6	TP #7	TP #8	Mean	SD
0	88	94	88	85	90	85	92	85	88.4	3.4
30	58	65	65	74	67	55	60	53	62.1	6.9
60	33	40	48	42	35	38	34	32	37.8	5.4
90	30	35	42	38	32	30	30	28	33.1	4.8
120	33	35	48	40	35	35	35	33	36.8	5.0
150	50	52	55	55	45	48	45	49	49.9	3.9
180	43	48	40	45	44	46	48	45	44.9	2.6
210	37	48	40	38	39	40	52	48	42.8	5.7
240	47	50	48	51	46	46	52	45	48.1	2.6
270	68	72	75	80	80	73	73	72	74.1	4.1
300	80	85	85	88	88	70	75	88	82.4	6.8
330	84	93	90	93	94	85	88	90	89.6	3.7

Table 4.
Subjective FOV (polar degree) for CVCH/MFS.

Azimuth	TP #1	TP #2	TP #3	TP #4	TP #5	TP #6	TP #7	TP #8	Mean	SD
0	88	92	90	90	90	88	88	85	88.9	2.1
30	56	65	60	68	65	55	61	52	60.3	5.6
60	32	39	47	41	33	36	35	32	36.9	5.2
90	29	33	40	37	31	33	32	28	32.9	4.0
120	32	35	46	39	33	35	35	36	36.4	4.4
150	50	48	53	53	42	45	43	49	47.9	4.2
180	41	47	38	42	39	44	45	43	42.4	3.0
210	39	40	35	37	37	40	48	46	40.3	4.5
240	37	30	50	30	28	33	38	34	35.0	7.0
270	45	48	42	39	43	47	45	48	44.6	3.2
300	56	58	58	54	54	54	68	64	58.3	5.2
330	82	75	72	82	82	72	74	72	76.4	4.8

Table 5.
Converted subjective FOV (linear degree) for ACH (unrestricted; helmet only).

Azimuth	Upper FOV	Lower FOV	Vertical FOV
-40	46.2	0.0	46.2
-30	52.0	-30.1	82.1
-20	53.8	-41.2	95.0
-10	54.9	-47.6	102.5
0	54.1	-52.3	106.4
10	53.8	-55.4	109.2
20	54.9	-58.1	113.0
30	54.9	-59.4	114.3
40	52.9	-59.2	112.1
50	48.6	-55.1	103.7
60	43.2	-50.0	93.2
70	33.6	-42.9	76.5
80	22.6	-30.1	52.7
		Mean Vertical FOV	**92.8**

Table 6.
Converted subjective FOV (linear degree) for ACH/MFS.

Azimuth	Upper FOV	Lower FOV	Vertical FOV
-40	46.0	3.0	43.0
-30	50.0	-18.1	68.1
-20	55.5	-25.2	80.7
-10	55.5	-21.0	76.5
0	54.0	-20.0	74.0
10	53.9	-29.3	83.2
20	53.9	-38. 8	92.7
30	55.1	-45.2	100.3
40	52.2	-48.8	101.0
50	48.5	-46.8	95.4
60	42.0	-41.2	83.2
70	34.3	-35.1	69.4
80	23.0	-25.0	48.0
		Mean Vertical FOV	**78.1**

Table 7.
Converted subjective FOV (linear degree) for CVCH (unrestricted; helmet only).

Azimuth	Upper FOV	Lower FOV	Vertical FOV
-40	34.9	-10.3	45.2
-30	38.0	-32.7	70.7
-20	38.9	-48.3	87.2
-10	38.9	-60.0	98.9
0	38.9	-68.7	107.6
10	39.1	-70.9	110.0
20	38.6	-70.9	109.5
30	38.9	-68.6	107.5
40	38.7	-67.1	105.8
50	39.1	-62.4	101.4
60	35.1	-56.1	91.2
70	26.7	-48.9	75.7
80	16.8	-37.8	54.6
		Mean Vertical FOV	**89.6**

Table 8.
Converted subjective FOV (linear degree) for CVCH/MFS.

Azimuth	Upper FOV	Lower FOV	Vertical FOV
50	45.6	0.0	45.6
40	49.7	-15.1	64.8
30	52.0	-14.4	66.4
20	54.8	-15.6	70.4
10	56.1	-23.3	79.4
0	54.0	-28.1	82.1
-10	54.6	-42.5	97.1
-20	55.7	-46.7	102.4
-30	55.7	-45.0	100.7
-40	50.7	-44.6	95.3
-50	45.2	-42.7	87.9
-60	44.0	-40.1	84.1
-70	40.8	-35.5	76.3
-80	38.3	-32.8	71.1
-90	33.5	-26.7	60.2
		Mean Vertical FOV	**81.3**

Table 9.
Objective FOV (linear degree) for ACH/MFS.

Azimuth	Upper FOV	Lower FOV	Vertical FOV
50	45.6	0.0	45.6
40	49.7	-15.1	64.8
30	52.0	-14.4	66.4
20	54.8	-15.6	70.4
10	56.1	-23.3	79.4
0	54.0	-28.1	82.1
-10	54.6	-42.5	97.1
-20	55.7	-46.7	102.4
-30	55.7	-45.0	100.7
-40	50.7	-44.6	95.3
-50	45.2	-42.7	87.9
-60	44.0	-40.1	84.1
-70	40.8	-35.5	76.3
-80	38.3	-32.8	71.1
-90	33.5	-26.7	60.2
		Mean Vertical FOV	**81.3**

Table 10.
Objective FOV (linear degree) for CVCH/MFS.

Azimuth	Upper FOV	Lower FOV	Vertical FOV
-50	29.5	0.0	29.5
-40	32.9	-15.3	48.2
-30	36.1	-15.7	51.8
-20	38.2	-15.9	54.1
-10	40.1	-28.5	68.6
0	41.1	-42.0	83.1
10	42.2	-44.0	86.2
20	42.7	-43.5	86.2
30	42.4	-44.6	87.0
40	40.3	-43.3	83.6
50	39.0	-41.6	80.6
60	35.4	-40.1	75.5
70	32.6	-35.5	68.1
80	29.7	-32.5	62.2
90	25.7	-29.9	55.6
		Mean Vertical FOV	**70.8**

Table 11
Comparison of FOV by subjective and objective methods.

	ACH		CVCH	
	Subjective	**Objective**	**Subjective**	**Objective**
FOV (degree)	78.1	81.3	68.3	70.8
FOV (%)	84.1	87.6	76.2	79.0
FOV Loss (%)	15.9	12.4	23.8	21.0

Table 12.
Accuracy of objective FOV measures.

Trials	Upper	Lower	Vertical FOV
1	40.5	44.8	89.6
2	40.9	44.7	89.4
3	40.6	44.6	89.2
4	41.1	44.4	88.8
5	41	44.8	89.6
6	41	45.2	90.4
7	40.9	44.5	89
8	41.4	44.4	88.8
9	41.2	44.8	89.6
10	40.6	44.7	89.4
Mean	**40.92**	**44.69**	**89.38**
SD	**0.29**	**0.24**	**0.48**
Min	**40.5**	**44.4**	**88.8**
Max	**41.4**	**45.2**	**90.4**
Range	**0.9**	**0.8**	**1.6**

Note: The difference between minimum and maximum upper and lower values are less than one degree.

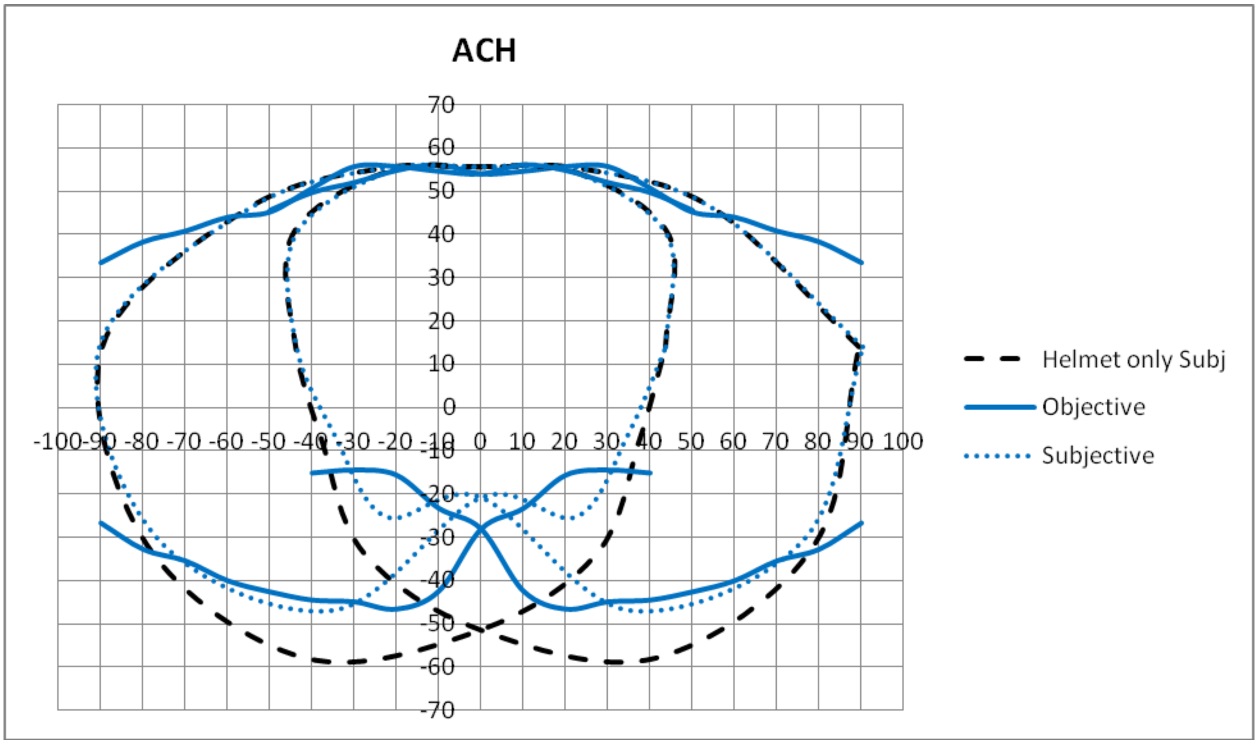

Figure 9. Comparison FOV graphs of ACH/MFS measured by objective and subjective methodology.

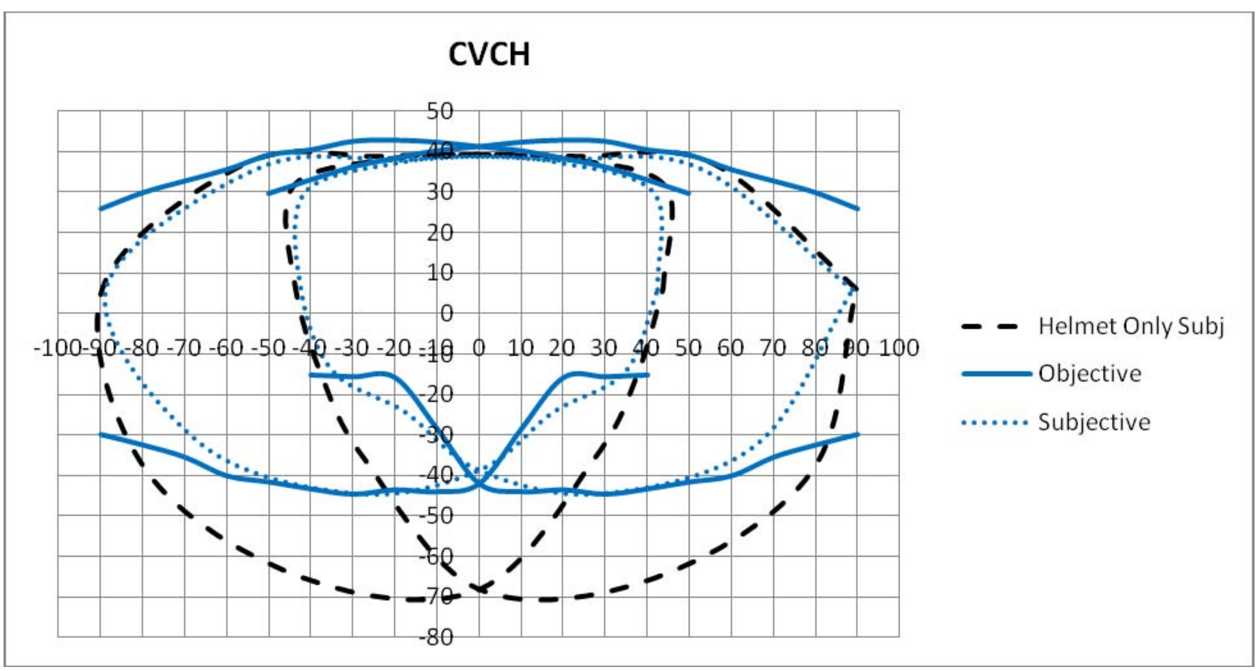

Figure 10. Comparison FOV graphs of CVCH/MFS measured by objective and subjective methodology.

Discussion

This evaluation showed that the use of an objective methodology yields similar results compared to the subjective FOV methodology. Objective FOV assessment will expedite the test and evaluation of future MFSs and give move accurate results by eliminating the variability induced by differences in participant's response time and device fitting. As would be expected, MFS reduced the user's FOV, especially in the lower hemisphere. The more facial area protected, the less the FOV. It is therefore important to understand how proposed integrated helmet/maxillofacial protection systems can affect the Warfighter's FOV, which in turn could negatively impact combat performance. Other test data (e.g., blunt impact, ballistics, back face deformation) should also be used in conjunction with FOV measurements to determine the combined head/face system(s) that will optimize protection without hindering the combat performance of ground and mounted Warfighters. In addition, decision makers must consider that these are static FOV measurements and that, in practice, the user will move the head as necessary to see what must be viewed. Therefore, the FOV restriction noted may be less troublesome in practice than the results may indicate. However, in many situations, head movement should or must be limited, meaning that FOV in an operational environment should be maximized to avoid extraneous head movement.

Conclusion

The objective FOV assessment using the laser pointer, digital inclinometer with a rigid head form on a rotating table will provide repeatable FOV measurements for comparison purposes among competing maxillofacial protective shields without the variability associated with human subjects.

References

Beebe, G. and DeBakey, M. 1952. Location of hits and wounds. Battle Casualties, 165-205. Springfield, IL: Charles C. Thomas.

Lew, T. A., Walker, J. A., Wenke, J. C.,Blackbourne, L. H., and Hale, R. G. 2010. Characterization of craniomaxillofacial battle injuries sustained by United States service members in the current conflicts of Iraq and Afghanistan. Journal of Oral and Maxillofacial Surgery. 68(1): 3-7.

Reister, F. 1973. Battle casualties and medical statistics: U.S. Army experience in the Korean War. Washington, DC. The Surgeon General, Department of the Army.

Revision Batlskin Mandible Guard Product Data. Last accessed 29 Aug 2012 from http://www.revisionmilitary.com/store/batlskin-mandible-guard-kit-for-ach-helmet-small-medium-and-large-x-large.html.

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